Integrating Wetland Inventory, Assessment and Monitoring into Local Watershed Plans and Montana's State Water Monitoring and Assessment Strategy

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EXECUTIVE SUMMARY

Impacts to wetlands can greatly affect watershed health because wetlands are such an integral part of watershed hydrology. Wetlands provide many watershed benefits including flood storage, erosion control and wildlife habitat; and perform as a natural filter that improves water quality. However, despite the strong connection between wetlands and watersheds, few agencies or communities comprehensively manage their wetlands in the context of local watershed plans. In Montana, as in other states, progress towards improving water quality and protecting and restoring our water resources has been hampered by our failure to recognize the need to comprehensively monitor and manage our water resources. Therefore, local land management agencies, governments and watershed groups have a very important role to play in wetland protection. These agencies and groups are often responsible for or can influence the land use decisions that can impact wetlands and watershed health. They can take a proactive approach to integrate wetland inventory, assessment and monitoring into broader watershed planning efforts.

The U.S. EPA has identified the development of a State comprehensive wetland monitoring and assessment program strategy as a top priority to determine the causes, effects and extent of pollution to wetland resources and to improve pollution prevention, reduction and elimination strategies. These strategies include identifying the cumulative effects of wetland loss, degradation and restoration on watershed health. In 2001 the EPA began funding the Montana Department of Environmental Quality to develop a comprehensive wetland program. Components of the program include developing the following: a comprehensive wetland inventory; monitoring and assessment program strategy; and tools which would allow managers to better assess their needs for implementation of wetland restoration and protection.

This document provides a flexible strategy that state and local agencies and watershed groups can consider for integrating wetland inventory, assessment, and monitoring into local watershed plans. The document also includes a description of the wetland inventory, assessment and monitoring tools that have been developed by DEQ and our partners; a literature review that can be used for additional guidance; and recommendations for developing a state program strategy and for integrating wetlands into local watershed plans.

FORWARD

This document includes guidelines, strategies, and recommendations for agencies and their partners to work with watershed groups and local governments to inventory, monitor and assess wetland resources and identify those in need of restoration and protection. The document was written for two audiences. The first audience includes the lead state agencies and their partners who help provide financial and technical assistance for watershed groups and local governments. The second audience includes watershed groups and local governments, who coordinate the development and implementation of local watershed plans. The focus of this document is on integrating wetland inventory, assessment and monitoring into local watershed plans and Montana's state water monitoring and assessment strategy. Additional guidance on how to use watershed plans to protect wetlands can be found at the Center for Watershed Protection.

The development of a wetland monitoring and assessment program that meets CWA requirements for monitoring, assessing and reporting condition of all waters in the U.S. (including wetlands) (40 CFR 130.4(a); 40 CFR130.8(b)(1)), has been a goal of both the U.S. Environmental Protection Agency (EPA) and the Montana Department of Environmental Quality (DEQ) since the early 1990's. To help meet that goal, this document includes a background discussion defining the relationship between inventory, monitoring, and assessment; a list of tools available in Montana; and a framework for how the tools can be applied to characterize and monitor wetlands and report on their condition.

Recently, due in part to recommendations from the National Academy of Public Administration (NAPA), EPA has been encouraging states to integrate their wetland monitoring and assessment program as a component of an overall water monitoring program to comprehensively manage aquatic resources, including wetlands, in the context of local watershed plans (71 FR 15718; U.S. EPA 2003; U.S. EPA 2005a-c; U.S. EPA 2006a). Therefore this document includes a strategy for integrating wetland characterization into a comprehensive watershed plan to encourage more effective and efficient use of limited financial and technical resources to improve overall water quality. The document also includes a discussion and recommendations for integrating wetland inventory, monitoring, and assessment into Montana's broader water quality programs.

RESOURCES

Development of the guidelines, strategies, and recommendations contained within this document relied primarily on the following guidance documents:

1. The Ramsar Convention for Wetlands – An integrated framework for wetland inventory, assessment and monitoring. The Convention on Wetlands is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. It was adopted in the Iranian city of Ramsar in 1971 and came into force in 1975, and it is the only global environmental treaty that deals with a particular ecosystem. The Convention's member countries cover all geographic regions of the planet. This document provides overall guidance on when and for what purposes to use the various different inventory, assessment and monitoring tools and guidelines and focuses on the purposes of and interrelationships among the different aspects and tools for wetland inventory, assessment and monitoring.

2. Community-based Watershed Management Handbook: Lessons learned from the National Estuary Program. This is an U.S. EPA handbook that describes innovative approaches to monitoring, assessment and watershed management implemented by the National Estuary Programs.

3. Understanding What States Need to Protect Water Quality. This document was produced by the National Academy of Public Administration, which is an independent nonprofit group chartered by Congress to improve governance at all levels. The document provides recommendations for EPA on how to improve the States' water programs.

4. Adapting Watershed Tools to Protect Wetlands. This document was produced by the Center for Watershed Protection which is a non-profit 501(c)3 corporation that provides local governments, activists, and watershed organizations around the country with the technical tools for protecting some of the nation's most precious natural resources: our streams, lakes, rivers and wetlands.

5. Using Local Watershed Plans to Protect Wetlands. This article was produced by the Center for Watershed Protection for the U.S. EPA. The article briefly describes a proposed framework for integrating wetland management in the context of local, state, and tibal watershed planning efforts.

6. Handbook for Developing Watershed Plans to Restore and Protect our Water Quality. This U.S. EPA handbook provides guidance to States and watershed groups regarding technical tools and sources of information for developing watershed plans that restore and protect all waters, including wetlands, and improves water quality.

7. Elements of a State Water Monitoring and Assessment Program. This U.S. EPA document recommends the basic elements of a State water monitoring program and serves as a tool to help EPA and the States determine whether a monitoring program meets the prerequisites of CWA Section 106(e)(1).

8. Elements of a State Water Monitoring and Assessment Program for Wetlands. This U.S. EPA document provides clarification and further information on how the original Elements document applies to wetlands.

9. Wisconsin Wetland Monitoring and Assessment. This is a website link to the Wisconsin Department of Natural Resources. Wisconsin is a leader in the development and implementation of wetland monitoring and assessment tools for watershed planning purposes.

10. Guidance on Systematic Planning using the Data Quality Objectives Process. This EPA document provides a standard working tool for project managers and planners to develop data quality objectives (DQO's) for determining the type, quantity, and quality of data needed to reach defensible decisions or make credible estimates.

11. Watershed Assessments of the Cottonwood and Whitewater Watersheds. This Montana Natural Heritage Program document describes a watershed approach for monitoring and assessing wetland resources in NE Montana.

PURPOSE OF A STATE WETLAND INVENTORY, MONITORING, AND ASSESSMENT PROGRAM

The U.S. EPA considers the development of a State comprehensive wetland monitoring and assessment program as a top priority to determine the causes, effects and extent of pollution to wetland resources, and to improve pollution prevention, reduction and elimination strategies (Fennessy et. al. 2004). They have recommended that staff from multiple state agencies devise the State's overall water monitoring strategy where wetland monitoring and assessment is integrated as a component of the broader strategy (U.S. EPA 2006a). A primary goal of such programs is to report on the ambient condition or changes in condition of the wetland resource. However additional objectives may include evaluating the environmental consequences of federal actions; evaluating the performance of wetland restoration projects; or identifying the cumulative effects of wetland loss, degradation and/or restoration in order to provide information that can be used to develop watershed restoration plans (U.S. EPA 2006).

The assessment tools that are presented within this document can be used to meet all of the goals and objectives identified by EPA. However, the primary purpose of this document is to provide guidance on how to integrate wetland inventory, assessment and monitoring into watershed planning. Therefore, this document is focused on methods and strategies for assessing and reporting on the condition of wetland resources and identifying the cumulative effects of wetland loss, degradation and/or restoration in order to provide information that can be used to develop watershed restoration plans. In addition, the document provides the rational for integrating wetland inventory, monitoring, assessment and management into watershed plans and Montana's state water monitoring and assessment strategy.

GENERAL GUIDANCE

In recent years both federal and state agencies have paid considerable attention to the importance of wetland inventory, monitoring and assessment as tools for wetland conservation, and for their use through local management planning processes to protect and restore wetland ecological character (Cappiella et al. 2006). This has lead to the development of numerous guidelines that states can follow to inventory wetlands and assess impacts. This document includes a review of literature that provides overall guidance for forming a cost-effective integrated framework for wetland inventory, assessment, and monitoring that is needed to promote wetland conservation. This document also includes strategies for using the wetland inventory, monitoring and assessment tools to increase public awareness and for understanding of the critical values and functions of wetlands.

Wetland Inventory, Assessment, Monitoring and Management

Wetland (baseline) inventory is the collection or collation of core information for wetland management, including the provisions of an information base for specific assessment and monitoring (Ramsar Convention on Wetlands 2005). This often includes establishing the location and ecological characteristics of wetlands within a region or watershed. Wetland assessment is the identification of the status of, and threats to, wetlands as a basis for the collection of more specific monitoring activities. Monitoring is the collection of specific information for management purposes in response to hypotheses derived from assessment activities. Management is taking action as a result of a monitoring effort to address changes causing or likely to cause damaging change in wetland function or ecological character (Ramsar Convention on Wetlands 2005).

Wetland inventory, assessments and monitoring can often be conducted simultaneously (Ramsar Convention on Wetlands 2005). For example, verification of wetland locations, biological surveys and wetland rapid assessments can be conducted at the same time (Maxell 2004a-b; Maxell 2005; Maxell 2006). However, wetland inventories are usually conducted before an assessment; while site-intensive assessments (e.g., biocriteria) are often conducted after a rapid assessment in order to validate the rapid assessment or to diagnose the causes of wetland degradation that were originally detected (U.S. EPA 2006a). Monitoring generally follows a wetland inventory and assessment to help direct future wetland management activities.

Wetland Inventory

Wetland inventories can be carried out at different levels of detail and a sequential inventory, starting simple and subsequently undertaking more detailed work, should be undertaken (Ramsar Convention on Wetlands 2005) . For example, GIS and remote sensing can be used to develop a coarse level of wetland inventory, with a follow-up inventory in the field to provide more detailed descriptions about the wetland types or complexes that were identified. The Montana Natural Heritage Program (MTNHP) is following this approach by first digitizing and mapping wetlands and then conducting field surveys to help further characterize the wetland types (MTNHP 2006).

Purposes for conducting a wetland inventory (Ramsar Convention on Wetlands 2005):

1. Mapping particular types or all wetlands in an area
2. Identifying wetlands of significant importance
3. Describing the occurrence and distribution of wetland taxa
4. Establishing a baseline for measuring change in wetland acres or quality
5. Assessing the extent and rate of wetland lost or degradation
6. Promoting awareness of the function and values of wetlands
7. Providing a tool for conservation planning and management; and
8. Developing networks of experts and cooperation for wetland conservation and management.

Additional information on wetland inventory can be found in the sections within this document that are titled "Montana's Wetland Assessment Tools" and "Components of Watershed planning Effort: Third Step - Characterize the Watershed".

Wetland Assessments

Wetland assessments can be conducted either intensively or rapidly. Site-intensive assessments are often used when a high level of certainty is needed or to diagnose the cause of a problem. A rapid wetland assessment is an approach which, depending on the purpose of the assessment, involves one or more of the different types of wetland assessments (listed on the following page). In this assessment type methods are adapted to permit the adequate collection, analysis and presentation of the assessment information when the information needs to be collected in a cost-effective manner for a large number of wetlands (Ramsar Convention on Wetlands 2005). A rapid assessment may also include the rapid collection of "baseline" wetland inventory information.

Types of wetland assessments (Ramsar Convention on Wetlands 2005):

1. Assessing impacts
2. Risk assessment
3. Vulnerability assessment
4. Status and Trends
5. Species-specific assessment
6. Indicator Assessment
7. Ecosystem Services (Functional assessments)
8. Assessment of values

Purposes of Rapid Assessments (Ramsar Convention on Wetlands 2005):

1. Collecting baseline inventory data to characterize wetlands
2. Gather information on the status of a targeted species
3. Gaining information on the effects of human or natural disturbances (changes) on a given wetland area or species;
4. Gaining information of landscape-level stressors that may be impacting wetland areas or species
5. Gathering information that is indicative of the general ecosystem health or condition of a specific wetland ecosystem

6. Assessing functions and values as a means to assign wetland ratings that can be used to prioritize management activities (Burgland 1999)

The Montana wetland rapid assessment method (MRAM) is a field-based method that was designed to collect data and information for most of these purposes, including the collection of baseline inventory data, and should be integrated with a landscape-level assessment to generate information that is most useful for making management decisions (DEQb 2005). For example, wetland inventory, degree of landscape-level stress and wetland functions and values are best determined by also considering landscape-level information[1].

Additional information on rapid and site-intensive assessments can be found in the sections within this document that are titled "Montana's Wetland Assessment Tools" and "Components of Watershed planning Effort: Third Step -Characterize the Watershed".

Wetland Monitoring and Management

Once the inventory and assessment baseline data have been acquired and adequately stored, more management-oriented information is often needed, which is often provided by monitoring wetland conditions, uses, functions and values, and land use and management. Wetland monitoring builds upon the information provided by the wetland inventory and assessment activities and is often based on a hypothesis derived from the assessment data to help direct management actions and policies. Monitoring often provides additional information through documenting temporal changes in wetland condition and function, or by providing a more focused investigation that can be used to direct management activities.

Consideration of Spatial Scales

Incorporating wetland protection into the local watershed planning process can help minimize impacts to wetlands by efficiently directing the application of local regulatory and conservation tools (Cappiella et al. 2006). Practically, this means that wetlands should be inventoried, assessed, monitored and managed in the context of the entire watershed to supplement the site-by-site regulatory-based assessments which are often necessary for addressing direct impacts such as dredging, filling or draining. A watershed approach also considers indirect wetland impacts that are caused by land use practices and requires a broader understanding of how wetlands function on the landscape and the benefits that they provide. For this reason, watershed planning allows communities to make better choices on preserving the highest quality wetlands by protecting the most vulnerable wetlands and for prioritizing sites for restoration (Cappiella et al. 2006).

At the watershed or regional level, an understanding of the status and trends of wetland ecosystems is essential for the establishment of policies, strategies and priorities for action (Ramsar Convention on Wetlands 2005). At the site scale, the establishment of the ecological characteristic features of a site, and the factors that are positively or adversely affecting or likely

[1] The Montana Department of Transportation (MDT) Wetland Form should be used if the primary purpose is to assess site-specific functions and values in order to assign an overall rating to facilitate avoidance priorities from proposed wetland disturbance-related activities, particularly highway projects (Berglund 1999).

to affect these characteristics, as determined by using a rapid or site-intensive assessment, are essential to the implementation of an effective regulatory program and management planning process (Ramsar Convention on Wetlands 2005). Monitoring wetland trends at both the watershed and site scale (temporal scale) provides for an indication of success of management actions and policies (Ramsar Convention on Wetlands 2005).

Whenever possible a wetland assessment should be conducted at a scale that is compatible with the scale of information contained within the inventory (Ramsar Convention on Wetlands 2005). Subsequent monitoring should also be undertaken at a scale compatible with the assessment and inventory. However, multi-scalar approaches are often appropriate for meeting a variety of objectives. For example, the study design that is used by the MTNHP for amphibian surveys combines site-specific information derived from a census of lentic wetlands within randomly selected 6th level HUCs with landscape-level assessments. This design allows wetlands to be assessed at the site level and at the watershed level (Maxell 2005).

The following is an example of a hierarchical approach for conducting wetland inventories that considers varying scales of information (Ramsar Convention on Wetlands 2005):

1. Studies that describe the broad geologic, climatic and ecological features of each geographic region using existing datasets. This is often a GIS exercise.
2. Studies to identify the location of wetlands within each geographic region. This often includes remote sensing and mapping.
3. Field work and analysis to identify the physical, chemical and biological features of wetland types or complexes within a targeted geographic region. This often includes the use of rapid assessments and site-specific indicators.
4. Detailed fieldwork and analysis to describe the physical, chemical and biological features of each wetland habitat within each wetland complex. This includes information on plants and animal assemblages and species (e.g., biocriteria), land and water use and wetland management.

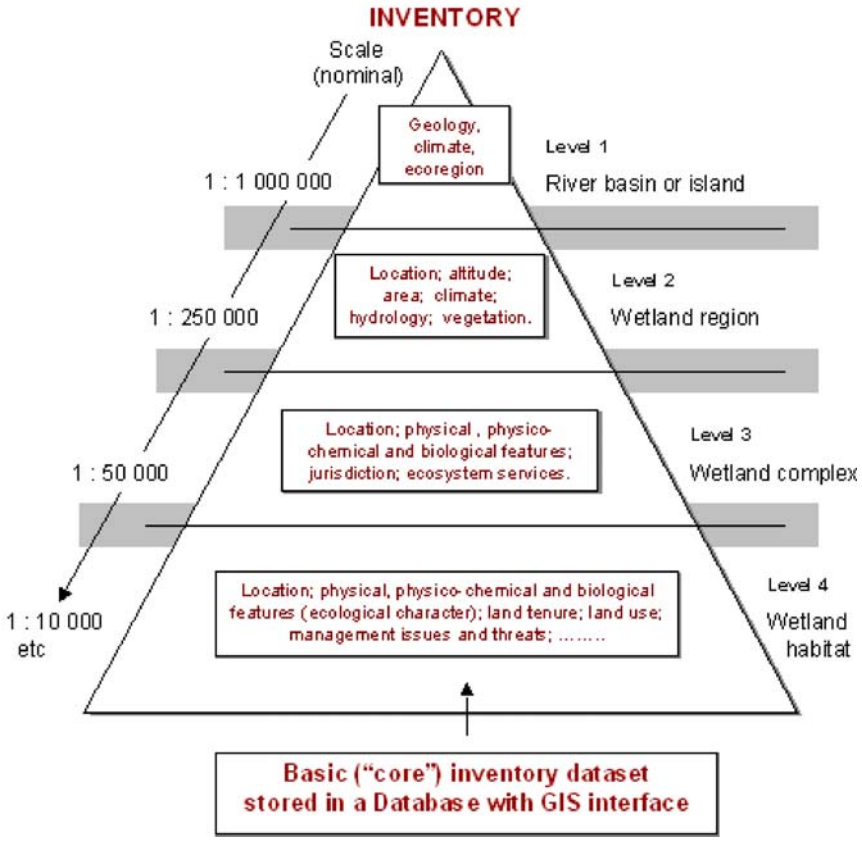


Figure 1. The hierarchical approach to wetland inventory. (Ramsar Convention on Wetlands 2005)

Similar multi-scalar procedures can be developed for wetland assessment and monitoring. These procedures will most likely build on the multi-scalar information collected under the inventory process and provide managers and others with analysis suitable for the scale of the investigation. However, detailed monitoring at broad scales is usually not possible because of the high cost. Thus, monitoring at this scale must be cost-effective and sufficiently rapid to generate adequate first-pass data over large areas (Ramsar Convention on Wetlands 2005). This is the reason that EPA considers rapid assessments to be a prerequisite for a state monitoring program (U.S. EPA 2006a). Rapid assessments are usually capable of providing information for a large number of wetlands that is adequate for management purposes and may help managers to decide what type of further information is required (Ramsar Convention on Wetlands 2005). Typically, rapid field assessment methods and remote sensing are applied at broad scales. However, even rapid field assessments can become too expensive or difficult to implement when the watershed is large or when site access is difficult. In this case, wetland assessments may rely more on remote sensing. However, for specific sites, more detailed, quantitative monitoring may be required to utilize methods that provide stronger inference about presumed impacts (e.g., biocriteria) (Ramsar Convention on Wetlands 2005).

Generally, effective watershed planning occurs at the scale of 100 square miles or less. At this scale, fewer jurisdictions and stakeholders are involved and impacts are more easily understood.

Also, the opportunities for watershed protection and restoration can be rapidly identified and implemented (Cappiella et al. 2006).

Assessing Wetland Status and Trends using Watershed-level Indicators

Watershed-level indicators are often designed to assess temporal patterns in the status and trends of ecosystems as well as the pressures and threats to habitats and species, and the responses made to address these pressures and threats (Ramsar Convention on Wetlands 2005). Watershed-level indicators are often dependant on having a variety of assessment tools including remote sensing, GIS, rapid field assessments and site-intensive assessments (e.g., identifying abundance and distribution of "species" across a landscape). Such indicators are not designed to provide a complete and comprehensive assessment of all aspects of wetland ecosystems and their dynamics: rather they are intended to provide a series of related pictures of these patterns. This helps guide further design and the focusing of decision-making for addressing unwanted change. These indicators are also generally components of hypothesis-driven wetland monitoring programs (Ramsar Convention on Wetlands 2005).

Watershed-level indicators include (Ramsar Convention on Wetlands 2005):

1. Trends in the extent of wetlands
2. Trends in abundance and distribution of native wetland taxa
3. Trends in the abundance and distribution of endangered or threatened species
4. Trends in wetland functions
5. Trends in water quality and wetland conditions (ecological character)
6. Trends in conservation status
7. Frequency of stressors or threats
8. Trends in the abundance and distribution of invasive species

Assessing Status and Trends using Site-level Indicators

Site-level indicators, which are used by rapid and site-intensive assessments, are used to characterize a wetland site. EPA recommends using site-specific indicators to make determinations that a wetland function is changed or lost to the point of affecting wetland condition and to portray those indicators as an organized set of questions (U.S.EPA 2006a).

Examples of site-level indicators that are used by rapid assessments to assess wetland condition include the following (Fennessy et al 2004):

1. Hydrologic alterations
2. Water quality observations (e.g., level of algae growth)
3. Soil/subsurface disturbance
4. Extent of invasive species
5. Vegetation alteration
6. Adjacent land use

Examples of site-level indicators that are used by site-intensive assessments to assess wetland conditions or functions include:

1. Floristic Quality Index (FQI)
2. Percent native or nonnative plants
3. Water quality analysis
4. Physical or hydrologic measurements

MONTANA'S WETLAND ASSESSMENT TOOLS

Approach: Three-Tier Framework

EPA has described the elements of an effective wetland monitoring program as a "three-tier framework" for wetland monitoring and assessment (Fennessy et. al. 2004; U.S. EPA 2006a;). This approach breaks assessment procedures into three levels that vary in intensity and scale, ranging from broad landscape-level assessments and mapping (Level 1); rapid field assessments (level 2); and intensive assessments (Level 3). Each level can be used to validate and inform the others. For example, data collected with a rapid assessment method can be used to validate and refine remote, landscape level techniques (Fennessy et. al. 2004). This strategy provides States and watershed groups the flexibility to use and integrate various levels of effort and a variety of tools to assess wetland conditions. Work may begin at any level, but each level builds upon the other (U.S. EPA 2006a). The following describes the three-tiered framework:

1. Landscape Assessment
   - Landscape assessments are used for wetland inventories that characterize land uses and the distribution and abundance of wetland types across an area.
   - Landscape assessments can be used to determine the geographical priorities where more intensive wetland monitoring is to occur, as well as identify environmental indicators that can be monitored to approximate wetland condition.
   - The resulting data layers and landscape profiles provide valuable information to guide wetland protection and restoration decisions, including the location and design of compensatory mitigation projects.

2. Rapid Wetland Assessment
   - Rapid wetland assessments evaluate the general condition of individual wetlands using relatively simple indicators. These assessments are based upon identifying stressors such as road crossings, encroachment, tile drainage and pipe discharges.
   - Rapid wetland assessment methods are used to monitor and report on the cumulative condition of wetlands in a watershed, as well as identify sites where more intensive monitoring is needed.
   - Results are also used in CWA Section 401/404 permitting and other wetland decisions and can be used to evaluate the performance of compensatory wetland mitigation and other restoration projects.

3. Intensive Site Assessment
    - Intensive wetland monitoring is necessary to test the indicators used in rapid wetland assessments and to validate landscape level assessments. Intensive-site assessments require the identification of wetland reference condition.
    - This level of assessment is also used to diagnose the causes of degradation and to determine the attainment of water quality standards at individual wetlands. Monitoring data is used to refine wetland restoration or other management practices where degradation is found.

Since 2001, EPA has provided funding to Montana for the development of a comprehensive wetland monitoring and assessment program strategy along with assessment tools. This program strategy allows managers to better assess needs for the implementation of wetland restoration and protection. Funding was originally used to develop vegetation and amphibian biological assessment tools (Level 3) and a GIS landscape assessment tool (Level 1) (Daumiller 2004). The development of bird biocriteria (Level 3) was added in 2003 (Noson et al 2005); a wetland rapid assessments method (Level 2) was added in 2004; and a rapid assessment database was added in 2005 (DEQ 2005b). The development of these assessment tools occurred primarily in SW Montana in the Red Rocks Region.

EPA has recently provided Wetland Demonstration Pilot Funding to develop and apply landscape assessment tools (Level 1) that can track wetland gains and losses, and add to the wetland assessment toolkit in the future (DEQ 2005a). The Wetland Program intends to initiate the Demonstration Pilot within the Gallatin, Flathead and Bitterroot valleys where wetlands are considered to be most at risk due to recent development pressures and changing land use. This 3-year effort includes developing a database to track wetland gains and losses, digitizing mid-1980's National Wetland Inventory (NWI) maps as a baseline. The effort also includes conducting wetland imagery analysis using 2005 color infrared (CIR) digital orthophotography to delineate and map current wetland-riparian areas. Wetland functions and descriptors will be assigned to the mapped wetlands by adding HGM and vegetation modifiers. Field surveys will supplement remote analysis. Trends in wetland acres, types and disturbance will be determined (MNHTP 2006).

Montana's Wetland Inventory, Assessment and Monitoring Tool Kit

Montana has limited resources for assessing wetland net loss or gain, function and condition. Therefore, the State needs to develop a strategy that integrates assessments and monitoring. This should be done by following EPA's recommendation for using a tiered approach, which provides flexibility for varying levels of effort to evaluate wetland quantity and quality. This strategy includes three levels of assessment ―landscape, rapid and intensive site assessments― to provide data that can be used to inventory, assess and monitor wetlands that will generate information that is needed to direct limited resources toward the protection and restoration of wetlands (DEQ 2005b). The data collection efforts for using these assessment tools should be well-coordinated and integrated so that multiple objectives can be achieved as efficiently as possible.

Landscape Assessments

The Natural Resource Information System (NRIS) developed a GIS-based assessment tool that uses landscape level indicators. Road density, population density and land cover are just a few of the indicators used to characterize watersheds for factors that have impacts on aquatic resources and are likely to affect their condition. The assessment is designed to rapidly characterize watershed at the 4th, 5th or 6th level HUC (NRIS, 2004). This method is useful for identifying and quantifying human activities that may be impacting the wetland resources by providing a coarse watershed assessment that relies on existing GIS layers. Therefore, it is unlikely that this method would be able to identify impacts that are caused by activities such as overgrazing, which may be difficult to determine using GIS.

A refinement of the NRIS GIS-based approach is currently being conducted by the MTNHP. The effort involves combining field-based assessments (e.g., rapid assessments) and remote sensing to help identify localized-landscape level stressors (within 300 meters) that are useful for predicting site-level wetland condition (MTNHP 2006a).

The MTNHP has been developing an approach using two series of aerial photographs (historic and current) to track wetland and riparian change over time. The effort included the creation of a crosswalk between the USFWS wetland and riparian systems and the Natural Resource Conservation Service (NRCS) land use and vegetation cover systems that was used for mapping on the Yellowstone River (Kudray and Schemm 2006).

The MTNHP is also developing a procedure for inventorying and delineating wetlands using color infrared (CIR) photography that digitizes wetland image data. The delineation is likely to include HGM and vegetation wetland modifiers and will use rapid field investigations to ground-truth wetland image analysis. The analysis will determine change in wetland acreages and types over time (trends) and the amount of wetland acres and types that are disturbed within a region (status) (MTNHP 2006c). Baseline conditions will be determined through assessing National Wetland Inventory (NWI) mapping data which is located at http://www.fws.gov/nwi/ . This effort includes the mapping and analysis of geographically isolated wetlands (MTNHP 2006b).

Rapid Field Assessments

Montana has developed a wetland rapid assessment tool that can be used to help inventory wetlands and assess wetland condition in the field (DEQ 2005b). It includes the documentation of wetland classification (both Cowardin and HGM) and inventories of amphibian, aquatic reptiles, and endangered and threatened species. Relatively simple metrics are used for assessing wetland conditions and identifying probable stressors and determining restorability. Montana's wetland rapid assessment method was designed as a "first cut" field evaluation for local watershed management planning purposes to help identify and prioritize wetlands within a watershed or region that may need additional protection or restoration. The method was also designed to be consistent with how DEQ conducts stream assessments. The form was designed so that it could be easily stored within a Personal Data Assistant (PDA). It can also be downloaded to a Microsoft Access database where the information and digital photographs could

be stored and retrieved for future watershed planning purposes (DEQ 2005b). Refinement of this method is ongoing.

Site-intensive Biological Assessments (Vegetation)

The MTNHP has developed assessment tools that use vegetation indices and a Floristic Quality Index (FQI) to assess the biological integrity of a site using vegetation (Jones 2004; Jones 2005). These methods were primarily developed for the riparian area of small-order streams in NE and SW Montana.

Vegetation biocriteria provides one of the best approaches for determining the site-specific trends of wetland condition because vegetation provides a sensitive measure of impacts to wetlands that respond to physical and hydrological alterations as well as changes in water quality (U.S. EPA 2002). The vegetation biocriteria can also be used to help diagnose the cause of degradation and to help verify preliminary assessments (U.S. EPA 2006a).

Floristic quality assessments were originally developed to provide a method for evaluating natural area quality to support conservation management decisions. The method relies on the understanding of individual plant species responses to disturbance, and fidelity to habitat integrity within a given region (Bernthall 2003). Methodologies for assessing biological integrity are based on research efforts that identify a stressor-response relationship between levels of human disturbance and elements of the biological system (Bernthall 2003). The method requires the collection of reference data during the growing season, including data that describe the human disturbance gradient, and recalibration for each ecoregion and wetland type. The method is labor-intensive, requires technical expertise and should be used sparingly when conducting watershed-level assessments.

A less costly alternative to the vegetation biocriteria is to only use the FQI which does not require the collection of reference data to calibrate the method. The FQI is capable of being used for a number of applications including the following (Benthall 2003):

- Identification of Natural Areas
- Comparisons among different sites
- Long-term monitoring of natural quality
- Monitoring of habitat restoration projects.

The FQI can also be used to demonstrate differences in plant assemblages in response to environmental variables (Bernthall 2003).

The FQI methodology can be most appropriately used with an understanding of its advantages and acknowledgment of its limitations. These are summarized by the following (Bernthall 2003):

Advantages

- Coupled with accurate, timely, and complete vegetation sampling FQI offers:
- A consistent, quantitative measure of plant community integrity.
- A method that can be used in any plant community (Vegetation biocriteria methods are necessarily restricted to a class of similar habitats).
- A repeatable method that can be used to assess trends.
- A subjective but expert-based system. Coefficients of conservatism are based on the collective knowledge of those familiar with a regional flora.
- A simple method that does not require extensive sampling equipment or
- laboratory processing.
- A method that can be applied to existing data, such as plant inventories.

Limitations

- Floristic quality is one aspect of ecological condition; the aggregate conservatism of the plant community.
- Comparability of results across wetland types is limited. Some wetland types,
- such as temporary ponds, may have naturally low plant diversity.
- Results may be strongly affected by observer expertise, restricting the
- comparability of results between observers of different skill levels.
- The time of year and intensity of sampling affect results. Many species will not be observable or identifiable by even the most skilled observer at certain times of the year. Repeated sampling over the course of a growing season will allow the closest approximation of the "true" FQI values, but this is not likely to be feasible in many situations.

Site-Intensive Biological Assessments (Birds)

The University of Montana has developed an assessment tool that uses bird indices to assess biological integrity (Noson et al 2005). The method was developed for assessing the riparian areas of small-order streams in NE and SW Montana. The method is most useful for assessing the influence of both site-level and watershed-level impacts on avian wetland habitats and for determining trends, especially for restored wetland complexes. It also provides a tool for engaging the public through citizen volunteer monitoring (Watercourse 2005).

Integrated Assessment using Amphibian Surveys

The MTNHP has developed a multi-tiered scheme for assessing and monitoring the status of amphibians in Montana (Maxell 2005). This assessment method integrates wetland inventories, amphibian inventories, watershed-level assessments and rapid site-level assessments (including habitat). It also provides a useful assessment tool for engaging the public through citizen volunteer monitoring.

The amphibian survey includes a statewide study design which stratifies sampling into different ecoregions across Montana. Within each ecoregion a census of all lentic wetlands is conducted within randomly selected subwatersheds (6th Level HUCs). This allows the status of individual

wetlands to be evaluated as well as the status of wetland habitats across the entire watershed (Maxell 2005).

Simultaneously conducting amphibian surveys and rapid assessments compliment one another by combining response variables that generally have a low strength of inference with regard to underlying processes at a given site (i.e., amphibian surveys). The response variables generally have limited spatial inference, but can be used for strong inference of processes that underlie observed patterns (i.e, rapid assessments) (Maxell 2005). It also provides a cost-effective approach for monitoring that meets multiple objectives, including ground-truthing wetland maps.

All amphibian and wetland rapid assessment data can be collected using a personal data assistant (PDA) and are entered into a Microsoft Access database. The data can be retrieved for watershed planning purposes by identifying sites and watersheds that have impacts such as infestation of noxious weeds, hydrologic modification, excessive grazing, nonnative fish, etc. (Maxell 2004a-b). The information can also be used to evaluate how the observed natural and anthropogenic disturbances impact amphibian communities (Maxell 2004a-b; Maxell 2006). Furthermore, the MRAM database and photographs can be linked to newly developed web applications at MTNHP to provide land managers across Montana easy access to this information in order to facilitate on-the-ground protection for wetlands. For more information please see the Montana Natural Heritage Program Information Portal (NHIP) at http://nhp.nris.state.mt.us/NHIP/default.aspx.

A SUGGESTED STRATEGY FOR INTEGRATING WETLAND INVENTORY, MONITORING AND ASSESSMENT AS A COMPONENT OF A WATERSHED PLANNING EFFORT

The Center for Watershed Protection has recently published an excellent document that explains how to use watershed plans to protect wetlands (Cappiella et al. 2006). Therefore, this document will focus on the wetland inventory, assessment, and monitoring component of the watershed planning effort which is described as technical characterization. These components of the watershed planning are provided in Table 1 as principles 1, 5, 6, 7 and 11.

Table 1. Watershed Planning Principles to Protect Wetlands

1 Compile Wetland Information on a Watershed Basis	1.1 Review Existing Plans 1.2 Compile Additional Data
2 Assess Local Wetland Protection Capacity	2.1 Conduct Needs and Capabilities Assessment 2.2 Conduct 8 Tools Audit
3 Identify Wetland Partners and Roles	3.1 Involve Wetland Partners in Stakeholder Process 3.2 Consult with Wetland Partners for Technical Support 3.3 Form Partnerships for Implementation
4 Define Wetland Goals and Objectives for the Watershed	4.1 Define Wetland Goals 4.2 Define Specific Wetland Objectives
5 Create an Inventory of Wetlands in the Watershed	5.1 Update Existing Wetland Maps 5.2 Estimate Historic Wetlands Coverage 5.3 Delineate Wetland Contributing Drainage Areas 5.4 Estimate Wetland Functions 5.5 Estimate Wetland Condition 5.6 Estimate Effects of Future Lnad Use Changes on Wetlands
6 Screen Wetland for Further Assessment	6.1 Screen for Priority Subwatersheds Using Wetland Metrics 6.2 Screen Wetland Inventory for Conservation Sites 6.3 Screen Wetland Inventory for Sensitive Wetlands 6.4 Screen Wetland Inventory for Restoration Sites
7 Evaluate Wetlands in the Field	7.1 Conduct Rapid Assessment of Wetland Impacts 7.2 Conduct Detailed Wetland Assessments
8. Adapt Watershed Tools to Protect Wetlands	8.1 Review 8 Tools Audit 8.2 Make Specific Recommendations for Each Tool
9. Prioritize Wetland Recommendations	9.1 Compile List of Wetland Recommendations 9.2 Rank Recommendations to Identify Priorities
10. Coordinate Implementation of Wetland Recommendations	10.1 Implement Changes to Local Programs and Regulations 10.2 Coordinate with Wetland Regulatory Agencies 10.3 Implement Projects with Wetland Partners
11. Monitor Progress Toward Wetland Goals	11.1 Update the Wetland Inventory 11.2 Track Implementation of Wetland Projects 11.3 Conduct Wetland Monitoring

(Cappiella et al. 2006)

The fundamental goal of technical characterization (using these inventory, assessment and monitoring tools) is to identify the problems facing the wetlands and to present the information in a way that supports the selection of actions for inclusion in a watershed plan (U.S. EPA

2005a). Each assessment tool addresses a specific objective and provides information at varying scales. These tools can and should be integrated so that monitoring of the wetland resource is conducted as cost-effectively as possible.

First Step – Build Partnerships (U.S. EPA 2005b)

The first steps that must be taken before inventorying, assessing and monitoring wetlands within a watershed are to:

- Identify stakeholders and partners
- Identify the issues of concern (e.g., use opinion surveys)
- Set preliminary goals
- identify indicators that can be measured
- Compile existing data
- Conduct public outreach (e.g., initiating outreach activities).

Experience has shown that effective watershed management includes active participation from stakeholders. It is particularly important to gather public input at the early stages of a watershed assessment for the establishment of long-term watershed assessment goals. This is often accomplished through public workshops and conferences and establishing citizen advisory groups (U.S. EPA 2005a).

Additional information on building partnerships can be found in articles provided by the Center for Watershed Protect, the EPA handbook for watershed plans and the EPA community-based watershed management handbook. This next section will focus on developing partnerships with staff from agencies, universities, nonprofits and consultants to serve as technical advisors; compiling existing data; and on monitoring activities that can be used for public outreach.

Identifying Partners that can serve as Technical Advisors

An important component of the watershed planning process is identifying stakeholders and partners. It is critical to align the efforts and resources of stakeholders towards common goals in order to adopt and implement a watershed plan. These stakeholders can generally be grouped into the general public, agencies, watershed partners and potential funders (Cappiella et al. 2006). The wetland partners have the unique ability to be technical advisors to the watershed plan and can assist with the development of a wetland inventory, assessment and monitoring strategy for the watershed. Communities may wish to consult with wetland partners such as wetland scientists and consultants and wetland regulatory staff to develop the technical characterization elements of the watershed plan (Cappiella et al. 2006). For example, partners can provide information on the rates and causes of historic and current loss and impacts to wetlands within the watershed; a list of wetland types in the watershed that are sensitive or perform important functions within the watershed; or they can recommend appropriate inventory, assessment and monitoring protocols.

List of potential partners that can be used as technical advisors:

1. State agencies such as DEQ, DNRC, FWPs, etc.
2. Federal agencies such as the NRCS, EPA, U.S. Army Corps of Engineers, BLM, USFS, USGS, USFWS, etc.
3. Local agencies
4. Universities
5. Nonprofit groups such as the MTNHP, National Audubon Society, etc.
6. Consultants

Compile Existing Data and Information

Wetland mapping data is often the most important type of wetland information to compile for a watershed plan (Cappiella et al. 2006). Geographic information systems (GIS) is the primary tool to store, organize and analyze all mapping data generated throughout the watershed planning process. Wetland mapping data includes both mapped wetland layers and wetland indicator layers which are used to infer where wetlands might be located. Preference should be given to the most recent and accurate layers available (Cappiella et al. 2006). The following tables 2 and 3 provide a summary of common wetland mapping and indicator layers and their sources.

Table 2. Wetland Mapping Layers

National Wetlands Inventory	Based on data from the 1980's, and tends to underestimate wetland coverage, specifically wetlands smaller than 3 acres and ephemeral wetlands. Maps cover 90% of U.S., but only 40% of the lower 48 states is available in GIS.	http://wetlands.fws.gov
State or Local Wetland Inventories	Local inventories can be the most accurate source of wetland data, but not all localities have them. Inventory completeness depends on intended use, procedures used, and difficulty of identifying certain wetland types	Varies (may be digital). Check with local planning agency, state natural resources department.
Natural Resources Conservation Service (NRCS) Wetland Determinations	Also known as farmed wetlands or "Swampbuster" maps. Available as paper maps only for individual sites.	Contact local Soil Conservation District office.
USACE Section 404 Permit Wetland Determinations	Paper maps of individual sites can be requested. A centralized database is under construction that may be searched by watershed.	Contact regional Army Corps for Engineers district office.
Created or Restored Wetlands	Locally generated layers of mitigation sites and stormwater treatment practices (STPs).	State transportation departments or USACE district office may be a good source for mitigation sites. Local public works or other department may have STP layer.
*NWI are currently being updated in certain USFWS priority areas using mid1990's and more recent imagery.		

(Cappiella et al. 2006)

Table 3. Wetland Indicator Layers

NRCS hydric soils and inclusions	State-wide or county-wide soil survey maps that designate hydric soils and inclusions (patches of hydric soil too small to map). Not all communities have soils digitally but you can get paper maps often from county soil conservation district.	http://soildatamart.nrcs.usda.gov/
Federal Emergency Management Agency (FEMA) Floodplains	Flood data is available for 100-year and 500-year floodplains.	http://msc.fema.gov
Topography	Digital elevation maps or Digital Line Graphs (DLGs).	Available from USGS and local sources.
State or Local Vegetation Maps and Surveys	Maps created from satellite imagery, plant surveys and other sources that identify wetland vegetation.	Varies
Aerial photos	High resolution aerials (no more than 5 years old and 1" – 600') can be used with photo interpretation to identify wetlands. Photos older than 5 years may be used if there has not been much recent development.	www.spaceimaging.com

(Cappiella et al. 2006)

Be aware that map-based information can be generated at several levels of detail which are related to the scale of the maps. A key consideration when using information from maps is the adoption of compatible data fields and data management procedures to allow maximum use of the data. However, for reuse of the data for different purposes, it is important to recognize the limits or constraints on interpretation of the original data. Therefore data collection and analysis should be based on standardized procedures and data management formats that reflect the appropriate scale (Ramsar Convention on Wetlands 2005).

Any available wetland monitoring and assessment data should also be compiled. Data on wetland water quality, hydrology or biological inventories may be available from Universities, the Montana Natural Heritage Program, or state and federal agencies. Information on tracking wetland permitting and wetland impacts can be found at the U.S. Army Corps of Engineers.

Conduct Public Outreach - Volunteer Monitoring

An important public outreach activity for engaging the public is volunteer monitoring. Volunteer monitoring should focus on monitoring and assessing wetland values and functions that the public are concerned about. This often includes surveying wildlife populations and assessing habitat conditions.

Bird or amphibian surveys are often useful as public outreach volunteer monitoring activities when interested stakeholders are identified. Rapid assessments can also be used in conjunction

with these biological surveys to document the occurrence of stressors such as identifying noxious weed infestations, hydrologic modifications, etc.
Bird surveys can be used to demonstrate how wetland restoration is improving bird habitat over time. Generally, it is best to focus on wetlands or wetland complexes that are near communities. The study design should include fixed locations that are routinely assessed throughout the spring and early summer. A more elaborate study design can also be developed for using birds to assess trends resulting from wetland restoration at a watershed or regional spatial scale. However this approach should be used sparingly as it takes a considerable amount of resources to coordinate and implement. The disadvantage to using bird surveys is that it requires that volunteers have the ability to identify the birds by sight and sound. It also requires repeated visits to a fixed location during the early morning. However, larger communities may have a sufficient number of dedicated citizen volunteers that have this expertise. The Watercourse received a high level of interest from volunteers when demonstrating this method in the Gallatin Valley (Watercourse 2005).

Amphibian surveys can be a useful tool for public outreach either through evaluating the status of amphibian populations or determining trends in amphibian populations over time. The surveys should focus on entire small-scale regions or watersheds. The study design generally requires that amphibian surveys should target all lentic wetland types within the region or watershed during the same time period (Maxell 2005). The advantages to this assessment tool are that only one or two days is needed per year to assess wetlands within a small watershed and it is relatively easy for citizen volunteers to learn how to identify the species. The disadvantage is that access to an entire wetland complex, region or watershed is usually needed to conduct the survey (not just one location).

Montana's rapid assessment method can be a useful tool that volunteer monitors can use to document probable stressors such as weed infestations. However, the rapid assessment method is fairly complex and would require a considerable amount of training to ensure that data are useful (DEQ 2005b). Therefore, only portions of Montana's rapid assessment method should be used for citizen volunteer monitoring. This may include only using the rapid assessment questions that assess the condition of the woody vegetation when conducting bird assessments, since the occurrence of birds is highly correlated to a high quality habitat structure. In other cases, the rapid assessment method may be used to document the occurrence of noxious weed infestations if this is a concern of the stakeholders.

Additional citizen volunteer monitoring activities could include monitoring water levels, surveying a species of interest, or establishing photo points.

Second Step – Develop Data Quality Objectives and a Quality Assurance Project Plan for the Watershed

Data quality objectives (DQOs) and a quality assurance project plan (QAPP) for assessing wetland resources should be developed after consulting with the stakeholders and partners to identify their concerns and goals and the indicators that can be measured.

The methods that are chosen for conducting wetland assessments are dependent on the DQOs that are established by consulting with stakeholders. For example, DQOs for identifying wetlands that are degraded will require different assessment methods than DQOs that are developed for determining how wetland conditions are improving due to restoration. The information compiled in the DQO process will be used to develop a watershed or project-specific QAPP, which should be used to plan the majority of wetland monitoring or assessment studies. Additional information are provided in Appendices A and B on how to develop DQOs and a QAPP.

The DQO process consists of seven steps (U.S. EPA 2005b). An example of how these steps can be applied to wetlands inventory, assessment and monitoring is provided in Table 4.

Table 4. Example of the Data Quality Objective Process Applied to a Wetland Inventory, Assessment, and Monitoring Program

STEPS	ACTION	EXAMPLE
Step 1. State the Problem	Consult with stakeholders and review existing information to describe the problem	Wetland conditions are degraded in Yellowbow Watershed
Step 2. Identify the Decision	Determine what questions the study will try to resolve and what actions might result	Need to determine the causes of degradation and where the priority areas are within the watershed.
Step 3. Identify inputs to the Decision	Identify information and measures needed to resolve the decision statement	Will use remote sensing, GIS and wetland rapid assessments to identify wetland locations and types and the causes of degradation and priority areas.
Step 4. Define the Study Boundaries	Specify temporal and spatial parameters for data collection; Resources that are available	The data and information will be collected from the entire watershed during 2006 and 2007. The focus will be on riverine and depressional wetlands. There is $25,000 available to conduct the assessment.
Step 5. Develop a Decision Rule	Define statistical parameters, action levels and logical basis for choosing alternatives	All wetlands that have a landscape human disturbance score >0.7 or a wetland rapid assessment score <0.6 will be considered degraded. Wetland rapid assessments can overrule landscape level assessments.
Step 6. Specify Tolerable Limits on Decision Errors	Define limits based on the consequences of an incorrect decision	A conservative approach will be used for flagging degraded sites to help ensure that all wetland sites that are degraded are identified. Therefore, approximately 20% of the sites that are flagged as being degraded will likely be unimpaired.
Step Step 7. Optimize the design	Choose the most resource-effective design that meets all DQOs.	Remote sensing and GIS will be used first to identify wetlands that are at risk; rapid assessments will be used to verify wetland classifications and landscape level assessments.

Third Step –Characterize the Watershed

After partnerships are built and DQOs and QAPPs are developed the next steps are to characterize the watershed (U.S. EPA 2005a). The fundamental goal for integrating wetland inventory, assessment and monitoring is to develop a cost-effective approach for identifying the problems facing the wetland resource within a targeted watershed or region and presenting that information in a way that supports the selection of actions for inclusion in a watershed plan. To satisfy this goal, wetland characterization within a watershed or region should proceed through the following tasks (U.S. EPA 2005a):

Task 1. Identify the wetland resources and describe their functions and values. This task often uses a landscape assessment to conduct a wetland inventory.

Task 2. Determine the condition of the resource (landscape function and wetland ecologic integrity). This task requires an assessment of the wetland resource using landscape, rapid and/or site-intensive assessments.

Task 3. Identify the priority problems that exist in the study area. This task uses the wetland assessment tools to inventory the problem areas.

Task 4. Identify likely causes of the problem and possible solutions. This task requires the use of landscape, rapid and/or site-intensive assessments to determine the causes of the problem.

Task 5. Provide input to the local watershed plan. This task often recommends additional monitoring using landscape, rapid and/or site-intensive assessments to verify the preliminary assessments, document trends or to help direct management activities and policies.

This technical characterization process addresses historical trends, present conditions, and probable future trends if current practices are not modified. Results are used to substantiate environmental problems, evaluate their causes, recommend future remedial and management strategies, and develop long-term monitoring plans (U.S. EPA 2005a).

The relationships among these tasks are presented graphically in Figure 2 and 3:

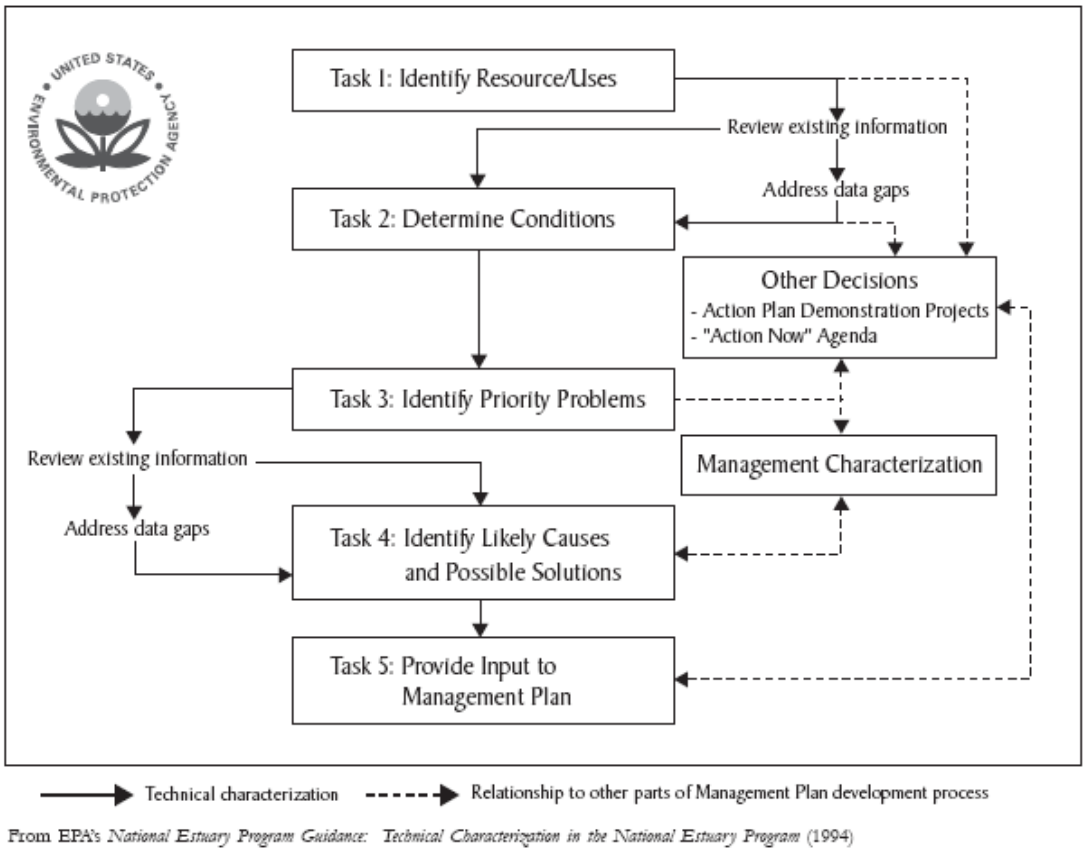
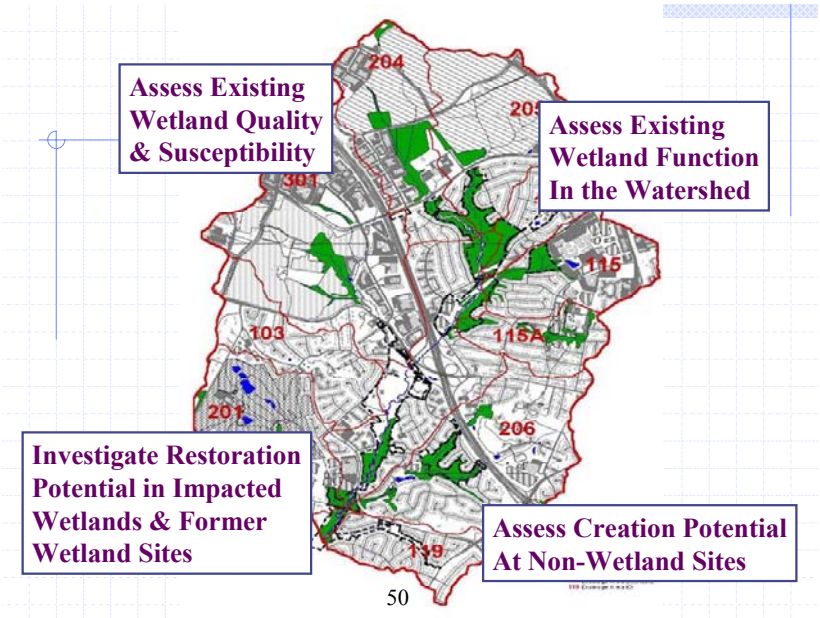


Figure 2. Wetland resource characterization task relationships (U.S. EPA 2005a)



Source: Center for Watershed Protection. www.cwp.org

Figure 3. Examples of wetland resource characterization assessments

Additional examples of using a watershed approach to characterize wetlands resources that can be used to inform managers or the public are located in Appendix C.

Wetland characterization often involves combining the use of landscape and rapid assessment protocols and biological surveys (e.g., amphibian surveys). A strategy should be developed to gather information that will optimize the ability to simultaneously meet multiple objectives that were identified by the stakeholders. For example, a landscape assessment can use remote sensing to locate and map wetland types and determine the amount of acres, while at the same time be used to gather information about landscape-level stressors and to identify wetlands that are at risk. A tiered or iterative approach should also be considered where information from digital orthoquads, NWI maps or existing GIS layers are used to identify wetland locations or general condition and a more refined method (e.g., CIR photography or field investigations) is later used to determine wetland types or identify modifiers or specific stressors. This tiered approach to wetland characterization generally follows the following sequence (Cappiella et al. 2006):

- Create a wetland inventory of the watershed
- Screen wetlands for further assessment
- Evaluate wetlands in the field using rapid assessments
- Conduct site-intensive wetland assessments

Create an Inventory of Wetlands in the Watershed

Watershed planning should always include a baseline assessment (i.e., inventory) of wetland resources in the watershed. A baseline assessment provides the information required to make decisions about what to do next. A wetland baseline assessment in a watershed is often completed using GIS and consists of the following six steps (Cappiella et al. 2006).

1. Update existing wetland maps (e.g., using recent aerial photos, hydric soil maps or aquatic vegetation surveys).
2. Estimate historic wetland coverages (Compare updated maps to historic maps and information).
3. Us topographic maps to delineate wetland contributing drainage areas to help identify potential sources of nonpoint source pollution that are impacting individual wetlands.
4. *Estimate wetland functions* which are defined as the ecological processes wetlands provide, such as flood attenuation or habitat.
5. *Estimate wetland condition* by describes how well the wetland is providing functions and values through assessing and comparing to the potential of the site.
6. Estimate effects of future land use changes on wetlands through analyzing patterns in future land use to identify potential wetland loss and prioritize wetlands for conservation.

This section of the document will focus on inventorying wetland functions and condition through using landscape-level assessments (Steps 4 and 5). For additional information see principle 5 in (Cappiella et al 2006).

Estimate Wetland Functions

Managing wetlands at the watershed scale requires an understanding of the functions that wetlands provide to the watershed. Just a few of these functions include flood storage, erosion control, wildlife habitat, groundwater recharge, sediment retention, and nutrient transformation.

(Cappiella et al. 2006). Estimating wetland functions allows watershed groups and local governments to quantify what watershed functions are currently being provided. It also allows them to identify wetland function goals, make recommendations for meeting the goals, and determine if the goals are being met.

Field-based assessments are necessary to accurately assess wetland functions. However, remote assessments are important when evaluating wetland functions at the watershed scale since it is often necessary to have some way to screen wetlands to target for further assessment. For this reason, desktop methods have been developed to make preliminary wetland functional assessments remotely at the watershed scale (Cappiella et al. 2006). For example, Tiner (2005) of the USFWS has developed a process for estimating wetland function through merging NWI data with USGS topographic maps and aerial photos to derive hydogeomorphic descriptors that are described by Brinson (1993). The MTNHP is currently following this process to map and estimate wetland functions (MTNHP 2006b).

Estimate Wetland Condition

Assessment of wetland functions generally only measures the wetland's capability to provide a function (Cappiella et al. 2006), whereas the assessment of wetland condition describes how well the wetland is actually providing those functions. For example, if the conditions of a wetland are degraded by an adjacent development, a wetland may only be functioning at half its potential capacity.

Wetland condition assessments are best conducted with a field assessment. However, preliminary estimates of wetland condition can be conducted at the landscape scale using desktop methods (Cappiella et al. 2006). Landscape-scale estimates of wetland condition focus on identifying indicators of disturbance such as land use or roads in and around wetlands. The assumption is that wetlands that have greater disturbance will have a more degraded condition. Montana has developed the following landscape model that can be used to make these estimates: GIS landscape assessment tool: watershed characterization for factors that have an impact on wetlands (Daumiller 2004).

Since the landscape methods are GIS-based the results are limited to the accuracy and availability of disturbance indicators. Therefore results should be verified and updated based on data from rapid field assessments. The combination of these two techniques ultimately provided a link between wetland condition and land disturbance.

Screen Wetlands for further Assessment

The wetland inventory is useful for identifying wetland locations and types, understanding wetland functions and estimating their conditions. However, decisions about which individual wetlands should be conserved, protected or restored should be based on field data. It is usually unrealistic to assess all of the wetlands within the watershed in the field (Cappiella et al. 2006). For example, it may be possible to assess all of the wetlands within a small watershed (e.g., using the study developed for conducting amphibian survey), but cost-prohibitive or physically impossible to assess all wetlands within a large watershed. Therefore, a number of approaches can be taken to narrow down or focus the field investigations, such as conducting a statistically-

based random assessment or by linking field-based assessments to landscape-level information (e.g., land use, land cover or ecoregion). The wetland inventory can also be screened to narrow down the sites for further assessment in the field to certain watershed locations and/or wetland types. Screening methods include the following (Cappiella et al. 2006):

- Screen for priority subwatersheds
- Screen wetland inventory for conservation sites that have high functional and are in good condition, or provide special economic or social values.
- Screen wetland inventory for wetlands communities that are sensitive to land disturbance
- Screen wetland inventory for restoration sites which includes former wetlands or existing degraded wetlands.

Evaluate Wetlands in the Field using Rapid Assessments

Good watershed plans always include some level of field evaluation to develop a better understanding of on-the-ground conditions and identify opportunities for improvement (Cappiella et al. 2006).

Rapid field assessments are very useful for characterizing watersheds and can be used to meet multiple objectives. For example, rapid assessments can be used to help managers do the following (Cappiella et al. 2006):

- Verify information in existing wetland inventories, including identifying any unmapped or unlisted wetlands.
- Document observable evidence of wetland impacts or stressors
- Provide enough data to support more detailed investigations of the potential for eliminating or reducing sources of impacts to wetlands.
- Develop, verify and update preliminary lists of wetland restorations sites, conservation sites and sensitive wetlands.

The study design that is used to implement a rapid assessment should address the objectives that are identified by the stakeholders and should consider the most efficient approach to address multiple objectives.

Rapid assessments can also be conducted simultaneously with wetland biological inventories, surveys and assessments and other chemical or physical site-intensive assessments. Often the largest part of a budget for assessing wetlands is to pay for travel expenses. Therefore it often makes sense to spend an extra 20-30 minutes to also conduct a rapid assessment to document the wetland types, probably stressors, and general condition. In addition, the site-intensive assessments can often be used to help validate, calibrate or diagnose the rapid assessment.

Conduct Wetland Site-intensive Assessments

The rapid assessment can be used to help identify which priority wetlands are appropriate for a site-intensive assessment, which often is not feasible to conduct on a watershed scale. Detailed functional assessments of individual wetlands are important to quantify wetland impacts and potential functional losses triggered by Section 404 permit activity. Establishing reference

condition for HGM functional assessments and biocriteria require extensive field assessment. Repeatable surveys also often require site-intensive assessments to establish baseline conditions and to monitoring trends (Cappiella et al. 2006). The following list provides some additional uses of site-intensive/detailed wetland assessments.

- Assess legal jurisdiction
- Determine groundwater contributions
- Compare functions/values for ranking wetlands
- Determine environmental impact of proposed development, road crossing, utility, adjacent septic systems
- Determine potential economic or recreational uses
- Evaluate ambient condition to establish aquatic life use standards
- Determine compliance with regulations
- Establish reference conditions for HGM classes
- Establish compensatory mitigation ratios
- Assess anthropogenic impacts and determine restoration potential
- Design wetland restoration projects
- Monitor performance of restoration and mitigation projects
- Establish baseline for monitoring long-term conditions

(Cappiella et al. 2006)

Final Step – Provide Input to a Management Plan and Identify Future Monitoring Needs and Solutions

After the watershed is characterized and the wetlands have been assessed the final step is to provide input to a management plan that (U.S. EPA 2005a):

1. Summarizes major environmental problems found.
2. Identifies suspected causes of the problems.
3. Recommends early actions and future remedial and managerial strategies; and
4. Identifies any additional monitoring needs for improving certainty about wetland conditions or diagnosing causes of degradation.

This effort generally includes three types of products that vary in their level of detail depending on the audience (For an example see www.mobilebaynep.com) (U.S. EPA 2005a).

1. Individual project reports provide technical information on the outcome of discrete studies.
2. A watershed characterization report that furnish a comprehensive description of wetland resources, including a summary of the results of individual project reports.
3. Public outreach summaries that provide a condensed version of the characterization report.

Watershed Assessment of Cottonwood and Whitewater Watersheds and Watershed Assessment of the Middle Powder Subbasin, Montana are examples of watershed characterization reports that integrate the assessment of wetland and riparian resources into watershed planning.

In addition, web-based databases can be developed to provide information to management and the public. The MTNHP is currently using this approach to provide biological information. For more information please see the Montana Natural Heritage Information Portal (NHIP) at http://nhp.nris.state.mt.us/NHIP/default.aspx.

Often additional monitoring is recommended to determine trends or to verify the preliminary assessments. For determining trends, future remote sensing or annual monitoring of vegetation, birds or amphibian populations is often recommended.

INTEGRATING WETLANDS INTO MONTANA'S STATE WATER MONITORING AND ASSESSMENT STRATEGY

Wetlands are impacted by land use activities that occur in or near wetlands, and within the watersheds that drain to them. Historically, wetland impacts have been regulated on a site-by-site basis by federal and state authorities. However, local land management agencies and governments have a very important role to play in wetland protection because they are responsible for the land use decisions that can impact wetlands, and can take a proactive approach that extends beyond individual sites to include the larger watershed (Cappiella et al 2005).

Impacts to wetlands can greatly affect watershed health because wetlands are such an integral part of watershed hydrology, and provide many watershed benefits, such as performing as a natural filter that improves water quality, flood storage, erosion control, and wildlife habitat. However, despite the strong connection between wetlands and watersheds, few agencies or communities comprehensively manage their wetlands in the context of local watershed plans (Cappiella et al 2005). In Montana, as in other states, progress towards improving water quality and protecting and restoring our water resources has been hampered by our failure to recognize the need to comprehensively monitor and manage our water resources. For this reason, EPA has developed guidance that recommends that appropriate staff from multiple agencies devise a State comprehensive water monitoring and assessment strategy and integrates the monitoring and assessment of wetlands into it (U.S. EPA 2003; U.S. EPA 2006a).

The comprehensive monitoring program strategy is a long-term plan that describes how the state implements a monitoring program. The plan determines water quality decision needs for all waters including streams, rivers, lakes, reservoirs, estuaries, wetlands, and ground water. The strategy should describe how the state addresses each of the other nine elements of the guidance (i.e., U.S. EPA 2003). It should reflect the input of the full range of monitoring partners within the state (71 FR 15718).

EPA's long-term goal is to enhance state and tribal capacity to implement an integrated monitoring framework which uses multiple tools to cost-effectively address the full range of water quality management decision needs (71 FR 15718). Over time, such program integration will foster coordination and prioritization of monitoring activities across all types of waterbodies (U.S. EPA 2006a).

A watershed approach to local wetland management is needed so that wetlands are no longer managed separately from other water resources or on a site-by-site basis (Cappiella et al 2005). The integration of wetland inventory, assessment and monitoring using a watershed as a sampling framework will help provide the data and information that are necessary for local managers to manage their wetland resources and to integrate wetland protection and restoration as a component of their watershed plans.

Watershed Approach

A watershed is an area of land that drains to a single stream or other water resources. Watersheds are defined solely by drainage areas and may include multiple landowners or cross political boundaries. The watershed approach is a coordinating framework for environmental management that focuses public and private sector efforts to address the highest priority problems within hydrologically defined geographic areas (e.g., watersheds), taking into consideration both ground and surface water flow.

EPA supports watershed approaches that aim to prevent pollution, achieve and sustain environmental improvements, and meet other goals important to the community. Although watershed approaches may vary in terms of specific objectives, priorities, elements, timing, and resources, all should be based on the following guiding principles:

- *Partnerships.* Those people most affected by management decisions are involved throughout and shape key decisions. This ensures that environmental objectives are well integrated with those for economic stability and other social and cultural goals. Partnerships also ensure that the people who depend on the natural resources within the watersheds are well informed and participate in planning and implementation activities.
- *Geographic focus.* Activities are directed within specific geographic areas, typically the areas that drain to surface water bodies or that recharge or overlay ground waters or a combination of both. Cooperation between multiple landowners and political jurisdictions is essential.
- *Sound management techniques based on strong science and data.* Collectively, watershed stakeholders employ sound scientific data, tools, and techniques in an interactive decision-making process. This process should include:
  - Assessment and characterization of the natural resources and the communities that depend on them.
  - Goal setting and identification of environmental objectives based on the condition or vulnerability of resources and the needs of the aquatic ecosystem and the people in the community.
  - Identification of priority problems.
  - Development of specific management options and action plans.
  - Implementation.
  - Evaluation of effectiveness and revision of plans, as needed.

When stakeholders work together, actions are based on shared information and a common understanding of the roles, priorities, and responsibilities of all involved parties. The nature of the watershed approach encourages partners to set goals and targets and to make maximum progress based on available information, while continuing analysis and verification in areas where information is incomplete.

Watershed projects should have a strong monitoring and evaluation component. Monitoring is essential to determining the effectiveness of management options chosen by stakeholders. Because many watershed protection activities require long-term commitments from stakeholders, they need to know whether their efforts are achieving real improvements in wetland or riparian area functions.

Operating and coordinating programs on a watershed basis makes good sense for environmental, financial, social, and administrative reasons. For example, by jointly reviewing the results of assessment efforts for NPS pollution control, fish and wildlife habitat protection, and other resource protection programs, managers can better understand the cumulative impacts of various human activities and determine the most critical problems in each watershed. Using this information to set priorities for action allows public and private managers from all levels to allocate limited financial and human resources to address the most critical needs.

The final result of the watershed approach is a plan that is a clear description of resource problems, goals to be obtained, monitoring to be conducted, and identification of sources for technical, educational and funding assistance. The successful plan provides a basis for seeking support and for maximizing the benefits of that support.

Source: USEPA, 1996b.

Source: (U.S. EPA 2005c)

Box 1. Making the Case for Wetlands and Watershed Planning

- Wetlands are indirectly impacted by uncontrolled stormwater discharges from adjacent or upstream development. Federal and state permitting programs do not regulate indirect impacts to wetlands. Indirect impacts can be effectively managed at the local level through land use and development regulations.
- Impacts to wetlands can greatly affect watershed health. Healthy wetlands provide many important watershed functions, such as pollutant removal, flood storage, erosion control, wildlife habitat, and groundwater recharge.
- Wetland regulatory programs currently do not distinguish between wetlands that have different functions. A watershed scale inventory and preliminary assessment of wetland functions allows communities to make more informed decisions about the highest quality wetlands to preserve, the most vulnerable wetlands to protect, and the best sites for wetland restoration, rather than using a site-by-site approach.
- Some isolated wetlands are outside the geographic jurisdiction of federal and state permitting programs. Local wetland protection regulations can be structured to capture these unprotected wetlands.
- A watershed plan can be used to inform wetland permit decisions made by state and federal agencies, and to identify the best opportunities for voluntary wetland conservation and restoration, as well as the most critical locations for wetland mitigation.
- Recent management of wetlands on a site-by-site basis has failed to meet "no net loss" of function standard (NRC, 2001). The current site-by-site approach does not consider cumulative impacts to wetlands. A local watershed approach to wetlands can do both these things.

(Cappiella et al. 2006)

Bringing people, priorities, policies and resources together through a watershed approach blends science and regulatory responsibilities with social and economic considerations. The very nature of working at a watershed level means that DEQ and its partners will work with stakeholders at the local level (e.g., Landowners, Local Water Quality Districts, County commissioners, Conservation Districts, local FWPs, DNRC, USFS, NRCS and BLM offices, etc.) to monitor, assess and improve watershed conditions, and protect and restore wetlands and riparian areas. The development of partnerships is an iterative process and can strengthen the end result by bringing in new ideas and input and by increasing public understanding of the problems. Partnerships also help identify and eliminate redundant efforts.

Recent constraints on public resources highlight the need for the States and EPA to target their investment on efforts that will enhance program performance and produce demonstrable improvements in water quality (NAPA 2002). The National Academy Public Administration (NAPA), which is a nonprofit group chartered by Congress, conducted research that demonstrated that more efficient strategies are available for managing many elements of the State's water programs. Among the most promising strategies listed (NAPA 2002):

- Focus management of water quality problems on a watershed-by-watershed basis. This means developing a comprehensive management plan that integrates and coordinates TMDL, NPDES permits, wetlands conservation, monitoring and nonpoint source strategies.

- Involve other State and Federal agencies in developing a single resource protection plan covering "all" activities affecting aquatic resources in particular regions or watersheds.

- Develop partnerships and cost-sharing arrangements with other Federal, State and Local agencies, nonprofit groups and local universities to fund or conduct research, planning, monitoring, and other work needed to control water pollution

- Work with volunteers from nearby communities to collect data on local water quality, participate in advisory councils, recommend priorities for the work of the states' water programs, and help disseminate information on water program results and funding needs.

Another NAPA finding was that the lack of information about environmental condition – including information about the water quality and sources of water pollution – has been a major obstacle to improving the effectiveness of state water quality programs (NAPA 2002). Investments in better environmental information, though often difficult given states' current financial conditions, can produce future benefits by helping states make more effective use of the limited resources they have. This can be achieved by developing cutting-edge methods for data collection, such as geographic information systems (GIS) and remote sensing (NAPA 2002). In addition, more rapid and less-expensive field data collection efforts can be used to collect information for more waterbodies. This can be done by following a tiered approach to monitoring that uses core indicators (e.g., landscape and rapid field assessments), and supplemental indicators which are used when there is a reasonable expectation that a specific pollutant or impact may be present in a watershed. This can also be done by supporting special studies that may involve screening for potential pollutants or impacts of concern (U.S. EPA 2003; U.S. EPA 2006a). Supplemental indicators (e.g., site-intensive assessments) are often the key for linking causes to sources of impairments and targeting appropriate source controls.

By working together to develop a common understanding of current environmental conditions, water programs can set priorities together and target shared resources to address major problems (NAPA 2002). For example, Kansas often inventories and prioritizes wetland and riparian monitoring and restoration in TMDL priority areas as a means to share program resources and technical expertise to improve water quality (Kansas Water Office 2003). Moreover, once problem areas are identified, better data should help states present compelling reasons for why additional funding is needed from state legislatures or Congress to cover gaps in fulfilling the requirements of the Clean Water Act (NAPA 2002).

Watershed Approach in Arkansas
The Arkansas Wetland Strategy does not replace other natural resource plans; it recognizes them and puts wetlands in context with other resource plans, such as NPS pollution management, floodplain management, habitat protection, ground water protection, and other water quality programs, for decision making at the watershed level. It also provides an ecosystem context by linking with regional wetland plans and priorities. Stakeholders (including wetland scientists, policy makers, landowners, and regulators) concluded that case-by-case wetland permitting does not result in a balanced conservation strategy. Case-by-case permitting tends to be inconsistent and confusing to landowners and usually does not result in "no net loss." The Arkansas Wetland Strategy promotes voluntary, incentive-based, locally lead conservation planning through the implementation of the strategy objectives.
Source: Multi-Agency Wetland Planning Team, 2001.

Source: (U.S. EPA 2005c)

For exploring possible sources of adequate and stable funding for water quality programs the DEQ should investigate opportunities to collaborate with other state and federal agencies that share the same concerns about protecting and restoring wetlands, improving water quality and reducing pollution (NAPA 2002). The Wetland Program has done an excellent job partnering with other State and Federal agencies that are focused on wetland issues. However, there are also opportunities for partnerships with other water programs that work on other aquatic resources, including within the DEQ. For example, DEQ faces significant workloads to develop TMDLs and to control pollution from non-point sources. A partnership with these programs to monitor, protect and restore wetlands within TMDL priority areas would meet the goals of both programs to conserve wetlands and improve water quality. Also, because many of the sources of nonpoint source pollution are agriculture operations, the wetland program may be able to qualify for funding from the new Farm Bill to expand agricultural conservation programs (NAPA 2002). While at the same time, they may also be able to form new partnerships with the DNRC, local conservation districts and watershed groups to work towards developing watershed plans that protect and restore wetlands and improve water quality (NAPA 2002). In fact, the Montana DNRC has already developed guidance and provides funding for assisting watershed groups to use a watershed approach for addressing wetland protection, water quantity and quality issues, riparian management, weeds management, habitat restoration, improving water quality, etc. (DNRC 2006).

RECOMMENDATIONS FOR DEVELOPING A STATE PROGRAM STRATEGY TO INVENTORY, MONITOR, AND ASSESS WETLANDS

1. DEQ should work with partners from other agencies, programs, universities and nonprofit groups to integrate the monitoring and assessment of wetlands with the overall state water monitoring and assessment strategy. This effort would require DEQ to solicit assistance from our partners and stakeholders to serve on a technical advisory committee to provide recommendations. The Water Quality Monitoring Workgroup, which is a subgroup of the Montana Watershed Coordination Council, may be an appropriate entity that could assist with this effort. This would improve efficiencies of all programs involved through leveraging financial and technical resources to meet multiple objectives as efficiently as possible.
2. The DEQ Wetland Program should coordinate with the Water Quality Planning Bureau as well as with other State programs such as the DNRC Conservation District Bureau and the Flood Plain Management Program. Together, these agencies could work with local watershed groups and governments to monitor, assess and restore aquatic resources, including wetland-riparian areas, through using a watershed approach. This can be initiated with a watershed pilot project to demonstrate the coordination and integration of wetland monitoring, assessment and management into watershed planning at the local level.
3. The DEQ Wetland Program should consider initiating a pilot project to demonstrate the use of a watershed approach while working with an experienced and well-organized watershed group or local government. An experienced watershed group or local government would be able to provide the valuable feedback on how to effectively use a watershed approach, and their efforts could serve as an example for other watershed groups or local governments could follow. This effort could possibly be funded by an EPA Watershed Protection Grant , EPA's Targeted Watersheds Grants Program, EPA Wetland Program development Grant or DEQ's Nonpoint Source Program.
4. DEQ and its partners should require that the monitoring grant proposals that are submitted by watershed groups or local government for watershed planning follow a data quality objective (DQO) process that includes QAPPs. This will ensure that the study design provides a sufficient amount of data quality and quantity to support the goals of the study. This process would allow DEQ and its partners the opportunity to provide oversight and technical assistance while also allowing local watershed groups and agencies the needed flexibility and control to answer the questions that are important to them. The DQOs and QAPPs could also be reviewed by a multi-entity technical committee to help rank and prioritize proposals for funding by State and Federal Grants. Nonprofit groups, such as the Montana Watershed Group, Inc., could be solicited for coordinating a technical committee for reviewing local watershed-based aquatic resource monitoring and assessment proposals. They could also potentially assist watershed groups and conservation districts with the development of their watershed plans. This would help ensure that the funding entities are coordinating with one another to meet common goals.

5. The DEQ Wetland and QA/QC program should develop a statewide (generic) QAPP for each of the three levels (landscape, rapid and site-intensive assessments) that watershed groups and local governments can use as a template. This would provide the monitoring and assessment framework that is needed to promote consistency and comparability. The generic QAPPs would specify the SOPs and level of quality assurance that is required for each activity. Montana Wetland Program staff, partners and collaborators would provide the SOPs, training, and technical assistance for public outreach activities and for conducting wetland assessments. Wetland inventory, monitoring and assessment SOPs, if not yet available, should be developed for each activity.
6. When the technical committee assists the watershed groups and local governments in the development of a study design, they should consider the multiple objectives that the stakeholders and partners have. Often a considerable amount of time, money and effort can be saved and a much more valuable product can be produced by slightly modifying a study design and sampling protocol in order to meet multiple objectives. This should occur while reviewing the DQOs and QAPPs.

RECOMMENDATIONS FOR WATERSHED GROUPS AND LOCAL GOVERNMENTS THAT ARE INTERESTED IN INVENTORYING, MONITORING, AND ASSESSING WETLANDS

1. Watershed groups and local governments should work with State and Federal Agencies to identify funding sources that they can use to inventory, monitor and assess wetland resources. Potential funding sources are listed at the following web site: http://water.montana.edu/watersheds/Resources/funding.asp.
2. Watershed groups and local governments should consider using landscape and rapid assessments to identify priority areas, probable stressors, and wetland restoration and conservation opportunities; and to inventory, ground truth and map wetlands and track wetland loss/gain. These assessment efforts need to follow consistent SOPs and have sufficient QA/QC. Therefore DEQ staff, partners or a professional with equivalent expertise should be used as a resource to provide the technical support, training and oversight that is needed (which will likely be a requirement for receiving grants). Generally, wetland inventory and mapping is the most important first step that is needed prior to conducting a wetland assessment across a landscape. The MTNHP program can provide the assistance that is needed to inventory and map wetlands within a watershed or region.
3. Watershed groups and local governments should consider using vegetation biocriteria or a vegetation floristic quality index (FQI) to determine trends, and to track wetland restoration and responses to management. Technical assistance is available from the MTNHP.
4. Watershed groups and local governments should produce products that can be easily incorporated into a management plan and understood by the public. Often GIS-based maps provide a useful approach for presenting information about wetland resources that can be incorporated into a watershed management plan. The MTNHP can provide assistance with presenting data and information for incorporation into a watershed plan. Public outreach brochures are useful for informing the public. The Montana Watercourse can provide assistance with the development of brochures.
5. Watershed groups and local governments should coordinate with the Montana DEQ, MTNHP and NRIS to provide the data and information in a database and website that is easily assessable to the public and managers (Click here to see an example website).
6. The public often values wetlands for the wildlife and habitats that they provide. Therefore, watershed groups and local governments should consider using bird, amphibian or vegetation surveys to engage the public and disseminate information. The Montana Watercourse, University of Montana and the Montana Natural Heritage Program could be used as a technical resource to provide assistance with this. Local Staff from other agencies such as the USFS, BLM, NRCS, DNRC and FWPs may also want to be involved, especially if wetlands on public or agricultural lands will be assessed. Nonprofit groups that may be interested in participating in or coordinating volunteer monitoring efforts include the Native Plant Society and the Audubon Society. Volunteer efforts could include documenting the infestation of weeds, inventorying a species of interest, monitoring water levels or establishing photo points.

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APPENDIX A – THE DATA QUALITY OBJECTIVE PROCESS

The data quality objective (*DQO)* Process is a series of logical steps that guides managers or staff to a plan for the resource-effective acquisition of environmental data. It is both flexible and iterative, and applies to both decision-making and estimation. The DQO Process is used to establish performance and acceptance criteria, which serve as the basis for designing a plan for collecting data of sufficient quality and quantity to support the goals of the study. The DQO Process leads to efficient and effective expenditure of resources. It also leads to a consensus on the type, quality, and quantity of data needed to meet the project goal, as well as the full documentation of actions taken during the development of the project (U.S. EPA 2006b).

The DQO process addresses the uses of the data (the decisions to be made) and other factors that will influence the types and amount of data to be collected (e.g., the problem being addressed, existing information, information needed before a decision can be made, and available resources) (U.S. EPA 2005b). The products of the DQO process are criteria for data quality, measurement quality objectives, and a study design that ensures that data will meet the criteria. For more information on DQOs, see EPA's *Guidance for the Data Quality Objectives Process* at www.epa.gov/quality/qs-docs/g4-final.pdf.

The purpose of the study, or the question that needs to be answered, drives the input for all steps in the DQO process. Thus, study design, data collection and use, and the types of analyses chosen should all stem from the overall purpose of the study.
For assessments that require answers to multiple study questions, the resolution of one key question may support the evaluation of subsequent questions. Often, the conclusions that are drawn early in such projects will be preliminary in nature and require only limited initial planning and evaluation efforts. However, as the study nears completion and the consequences of drawing an incorrect conclusion become more critical (e.g., implementing management actions), the level of effort needed to resolve the study questions generally will become greater (EPA 2006b). This iterative application of the DQO Process is illustrated in Figure 4.

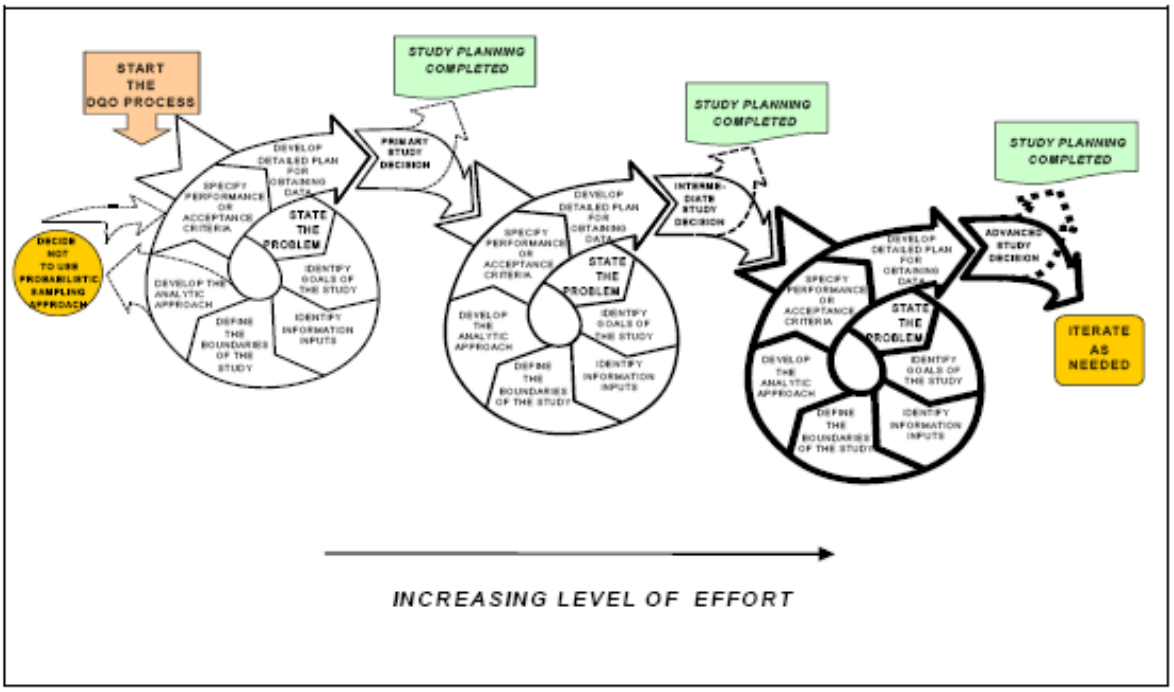

Figure 4. How the DQO process can be iterated sequentially
(U.S. EPA 2006b)

A wetland monitoring and assessment program should find a balance between obtaining information to satisfy the stated DQOs or study goals in a cost-effective manner and having enough confidence in the data to make appropriate decisions. Understanding the performance characteristics of methods is critical to the process of developing attainable data quality goals, improving data collection and processing, interpreting results, and developing feasible management strategies (U.S.EPA 2005b). By calculating the performance characteristics of a given method (such as wetland rapid assessments), it is possible to evaluate the robustness of the method for reliably determining the condition of the aquatic ecosystem. A method that is very labor-intensive and requires a great deal of specialized expertise and, in turn, provides a substantial amount of information is not necessarily the most appropriate method if it lacks precision and repeatability (U.S. EPA 2005b). A less-rigorous method might be less sensitive in detecting perturbation or have more uncertainty in its assessment. All of these attributes are especially important to minimizing error in assessments. The number of samples collected and analyzed will reflect a compromise between the desire of obtaining high-quality data that fully address the overall project objectives and the constraints imposed by analytical costs, sampling effort, and study logistics (U.S. EPA 2005b). The ultimate question resides in a firm balance between cost and resolution, i.e., Which is better—more information at a higher cost or a limited amount of the right information at less cost (EPA 2005b)?

APPENDIX B – THE QUALITY ASSURANCE PROJECT PLAN

A quality assurance project plan (QAPP) is a project-specific document that specifies the data quality and quantity requirements of the study, as well as the procedures that will be used to collect, analyze, and report those data (U.S. EPA 2005b). EPA-funded data collection programs must have an EPA-approved QAPP before sample collection begins. A QAPP helps monitoring staff follow correct and repeatable procedures, and helps data users ensure that the collected data meets their needs. A QAPP also ensures that the necessary quality assurance (QA) and quality control (QC) steps are built into the project from the beginning (U.S. EPA 2005b).

A QAPP is prepared before sampling begins, and it usually contains a sampling plan, data collection and management procedures, and training and logistical considerations with their QA/QC components (U.S. EPA 2005b). The intent of the QAPP is to help guide operation of the program and specify the roles and responsibilities of each member of the monitoring program team, all the way from the project manager and QA/QC officer to the staff responsible for field sampling and measurement (U.S. EPA 2005b). Project management responsibilities include overall project implementation, sample collection, data management, and budget tracking. Quality management responsibilities might include conducting checks of sample collection or data entry, data validation, and system audits (U.S. EPA 2005b). The QAPP also describes the tasks to be accomplished and how they will be carried out. DQOs for the data to be collected are listed along with any special training or certification that is needed by participants in the monitoring program. Lastly, it specifies the kinds of documents and records to be prepared and how they will be maintained. A key element of a QAPP is the SOP. SOPs help to maintain data comparability by providing step-by-step descriptions of technical activities that ensure consistency with sampling, analysis, and data handling activities (U.S. EPA 2005b).

The QAPP also contains assessments for reviewing progress and performance (e.g., technical reviews, audits), as well as how nonconformance can be detected during the monitoring program (U.S. EPA 2005b). Finally, procedures are described for reviewing and validating the data generated; dealing with errors and uncertainties identified in the data; and determining whether the type, quantity, and quality of the data will meet the needs of the decisionmakers. QAPPs should be continually refined to make them consistent with changes in the field and laboratory procedures. Each refinement should be documented and dated to trace modifications to the original plan (U.S. EPA 2005b).

For assistance in developing an effective QAPP, visit EPA's Web site for Quality Management Tools—QA Project Plans at www.epa.gov/quality/qapps.html.

APPENDIX C – EXAMPLES OF WETLAND ASSESSMENT INFORMATION THAT CAN BE PROVIDED TO MANAGERS OR THE PUBLIC

Figure 5 through 9 provide examples of wetland assessment information that can be provided to managers or to the public.

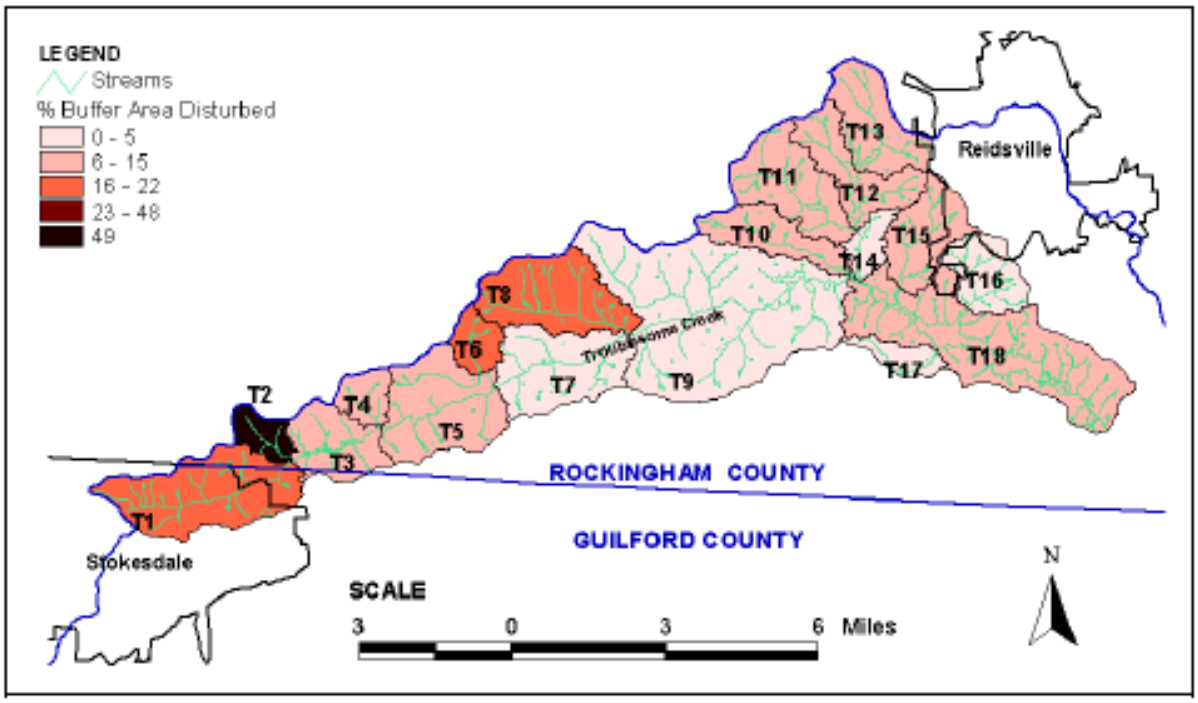

Figure 5. Percent riparian areas disturbed
(U.S. EPA 2005b)

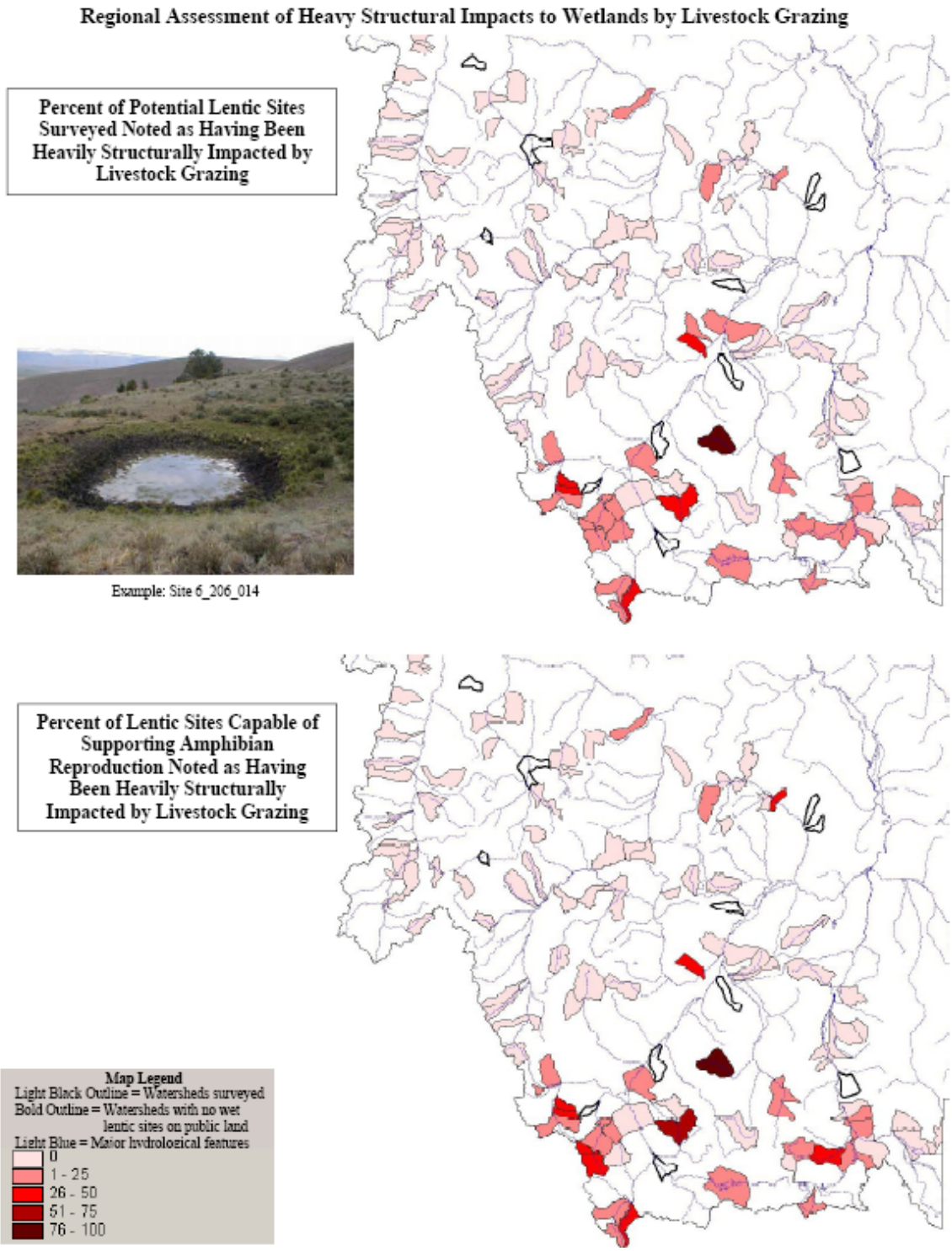

Figure 6. Integrating amphibian surveys with rapid field assessments to conduct watershed assessments (i.e., Habitat) in the Beaverhead-Deerlodge National Forest
(Maxell 2004b)

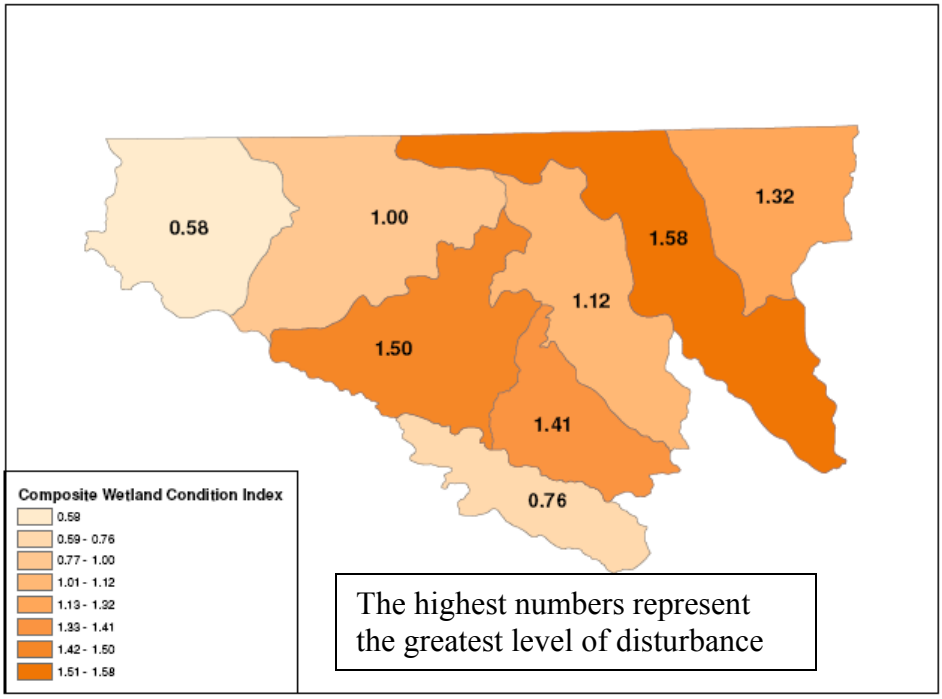

Figure 7. Using landscape assessments to develop a wetland condition index for the Cottonwood and Whitewater watersheds.
(Vance 2005)

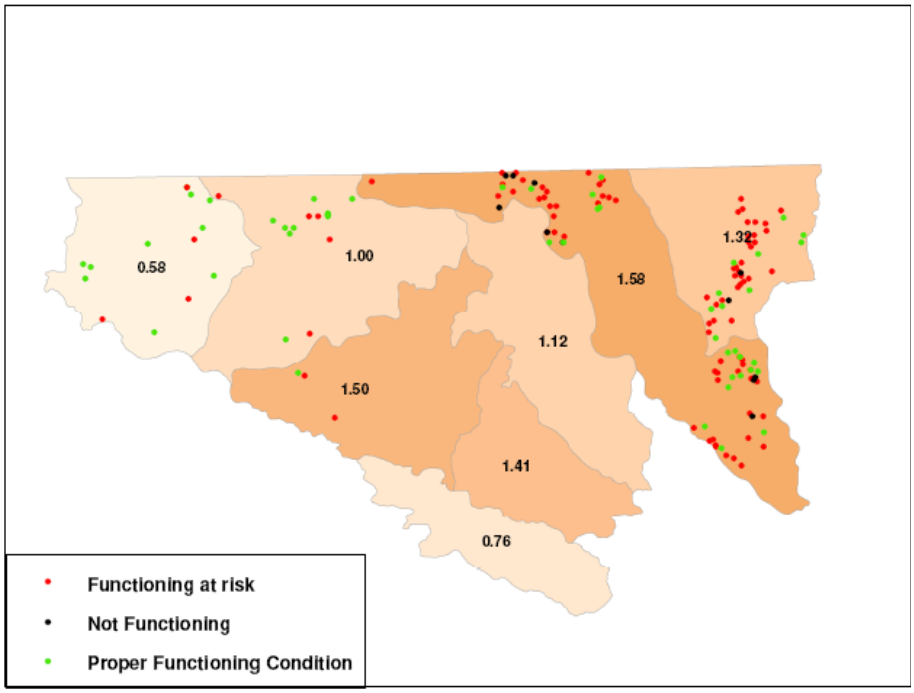

Figure 8. Integrating landscape level assessments with rapid field assessments (i.e., Proper Functioning Condition)
(Vance 2005)

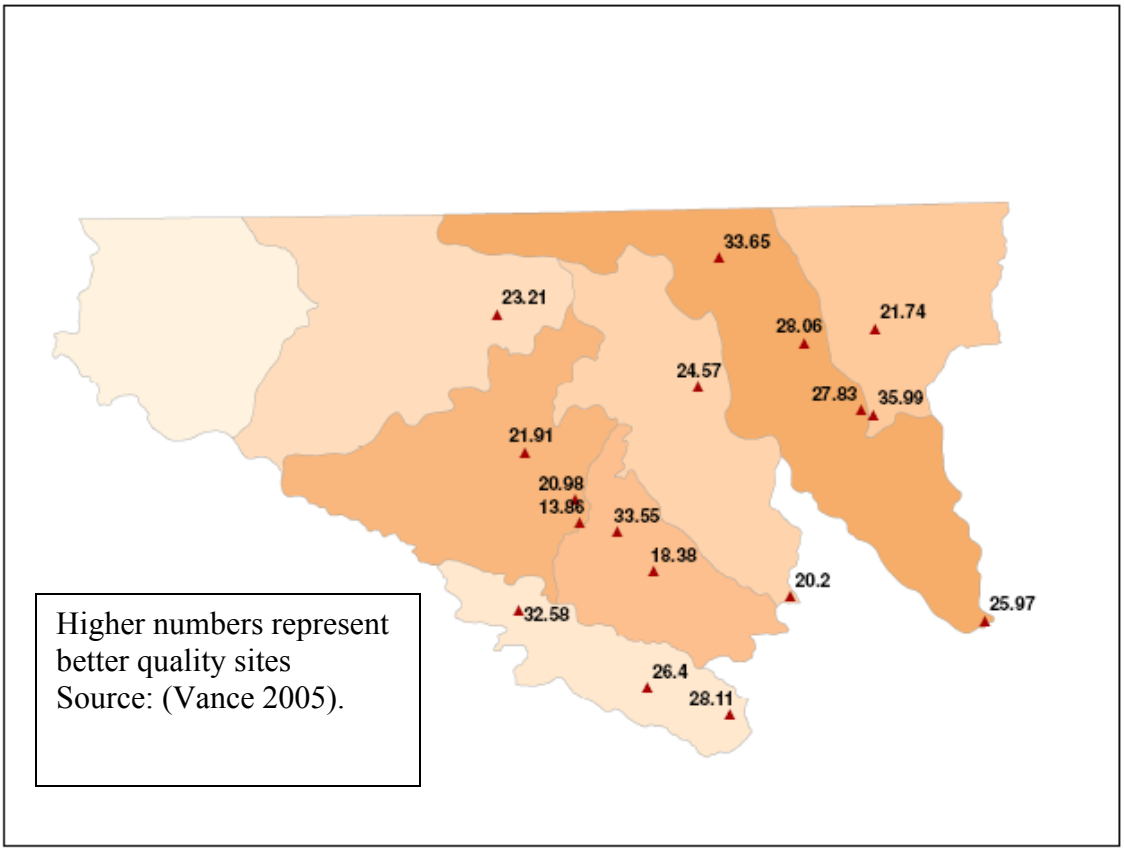

Figure 9. Assessing wetland condition using the Floristic Quality Index for herbaceous plants and % nonnative species of riparian sites in the Cottonwood and Whitewater watersheds (example of a site-intensive assessment)

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